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NATIONAL AIRSPACE SYSTEM MODERNIZATION





This chapter provides an overview of the FAA's plans for the modernization of the NAS, including the NAS Architecture, the Capital Investment Plan, and the Operational Evolution Plan. It also provides an update on significant modernization projects, Free Flight operational tests and Safe Flight 21.

The NAS is a comprehensive plan for modernizing the NAS and improving services and capabilities through the year 2015. The architecture is a living document: it is a web-based information system that provides a continually updated picture of technical and procedural aspects of the NAS.⁶

The NAS Architecture was developed by the FAA in collaboration with the RTCA and is based on aviation community recommendations for a Free Flight operational concept. Free Flight centers on allowing pilots, whenever and wherever practical, to choose the optimum flight profile. This concept of operations is expected to decrease user costs, improve airspace flexibility, and remove flight restrictions.⁷

The FAA produces another planning document, the Capital Investment Plan (CIP), a subset of the NAS Architecture, every year. The architecture and the CIP are aligned to the Office of Management and Budget's (OMB) five-year budget planning guidance and funding proposed under the FAA reauthorization bill (AIR-21). The CIP balances investments among safety, security, and efficiency initiatives. Operating improvements are focused on sustaining existing core services, which provide traffic separation, navigation, communications, and traffic flow management. The current CIP for 2002-2006 aligns NAS modernization to the FY 2001 capital appropriation and OMB funding projections for FY 2002 through 2006.

In FY 2001, another subset of the NAS Architecture, the Operational Evolution Plan (OEP), was developed. The OEP is a joint FAA/industry effort to define the necessary safety analyses, staffing, certification, training, procedures development and airspace actions necessary to address capacity and demand problems in the NAS. The OEP was released to the public and presented to the Congress in testimony by the FAA Administrator in June 2001. As 2001 comes to a close, some OEP projects have been completed and other projects are being reclassified and rescheduled.

A key feature of the OEP is its identification of the responsibilities and duties of the key players in the industry, each of whom must make their own contributions in order to increase the capacity and efficiency of the NAS. Figure 6-1 lists the responsibilities and the commitments of the three key parts of the aviation community in implementing the findings of the OEP and by phase of the plan.

6 The complete NAS Architecture 4.0 and a summary called the Blueprint for NAS Modernization are posted on the FAA web site at www.faa.gov/nasarchitecture. The architecture database can be accessed through the Capability Architecture Tool Suite.

7 The NAS Architecture was reviewed by the RTCA in July 2001, which found it to accurately reflect the aviation community's requirements through 2001.

Figure 6-1 OEP Summary of Responsibilities and Required Actions

Near-Term 2001

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|-----------------|---|
| <i>Airports</i> | <ul style="list-style-type: none"> ➤ Reach agreement with pilots on LAHSO procedures and assumptions ➤ Training on closely spaced approach procedures ➤ Improve quality of data and participation in Spring 2001 collaboration ➤ Participate in Spring 2001 training ➤ Improve information dissemination to passengers ➤ Improve and share demand forecast data ➤ Reevaluate scheduling practices at congested airports |
| <i>FAA</i> | <ul style="list-style-type: none"> ➤ Runway incursion training and awareness for controllers ➤ Conduct safety analyses for LAHSO ➤ Parallel runway monitors at selected airports ➤ Improve dissemination of routing information and weather to facilities ➤ Develop and conduct Spring 2001 training ➤ Resolve airspace choke points by adding new sectors and moving flows in NE ➤ Improve currency and accuracy of SUA status information and expand internet access ➤ Streamline EIS processes ➤ Improve information dissemination to passengers ➤ Expand use of 3-mile separation standard where applicable ➤ Start FFP2 program |
| <i>Airports</i> | <ul style="list-style-type: none"> ➤ New runways at Detroit and Phoenix ➤ Additional precision approaches at 14 airports ➤ Work with communities to implement capacity plans ➤ Streamline EIS processes ➤ Improve information dissemination to passengers |

Mid-Term 2002-2004

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|-----------------|--|
| <i>Airlines</i> | <ul style="list-style-type: none"> ➤ Accelerate equipage to take advantage of RNAV routes and approaches ➤ Ensure uniform datalink equipage ➤ Reevaluate scheduling practices at congested airports |
| <i>FAA</i> | <ul style="list-style-type: none"> ➤ Expand implementation of RNAV procedures ➤ Provide staffing and equipment for new runways ➤ Parallel runway monitors at selected airports ➤ Complete FFP1 program ➤ Expand airspace redesign, start to implement RVSM ➤ Complete WAAS Phase 1 (LNAV/VNAV) ➤ Implement LAAS approaches ➤ Add datalink and ADS-B capabilities |
| <i>Airports</i> | <ul style="list-style-type: none"> ➤ New runways/extensions at Houston, Minneapolis, Miami, Orlando, Charlotte, Denver ➤ Improve surface management process and coordination ➤ Start LAAS implementation ➤ Add signs and lighting at smaller airports to take advantage of new navigation Systems |

Long-Term 2005-2010

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|-----------------|--|
| <i>Airlines</i> | <ul style="list-style-type: none"> ➤ Equip for enhanced situational awareness on airport surface ➤ Equip and train for new LAAS systems |
| <i>FAA</i> | <ul style="list-style-type: none"> ➤ Transition to single facility operation in New York ➤ Continue TRACON consolidation ➤ Implement RVSM ➤ Complete WAAS Phase 2 ➤ Expand use of datalink for ATC |
| <i>Airports</i> | <ul style="list-style-type: none"> ➤ New runways and taxiways at Atlanta, Cincinnati, Dallas, St. Louis, Seattle, Dulles ➤ Enhance surface congestion management ➤ Continue to add capacity through taxiway and runway enhancements |

NAS Modernization has been designed as an evolutionary process that will sustain current NAS operations while new technologies are introduced, proven, and then deployed. This process will allow for a smooth transition from one technology to another, sufficient time for users to equip, and realistic schedules for service providers to test, train for, and deliver services.

6.1 Update on NAS Modernization

NAS modernization is an ongoing process that builds upon the implementation of individual projects to improve the effectiveness of the entire NAS. The 2000 ACE Plan reported on several significant milestones in NAS Modernization:

- The deployment of the Display System Replacement (DSR) equipment, the first major component of the en route air traffic control system infrastructure, which was completed on time and within budget.
- The completion of the HOST and Oceanic Computer Replacement, which replaced aging computers at the centers with new equipment with higher reliability, has improved maintainability, and more complete backup capability.
- The installation of the Common Automated Radar Terminal System to upgrade the dated system at 133 small-to medium TRACONS and to enhance the existing systems at five large TRACONS.

The incremental nature of NAS modernization means that these accomplishments provide the foundation for subsequent projects. In the past year, the main focus of NAS modernization has switched from the en route environment to the terminal area, focusing on the development and early prototypes of the Standard Terminal Automation Replacement System, the beginning of the HOST software rewrite, and the development of the Local Area Augmentation System. Each of these initiatives is described briefly below.

6.1.1 The Standard Terminal Automation Replacement System

The Standard Terminal Automation Replacement System (STARS) is a joint FAA and Department of Defense program to replace automated radar terminal systems (ARTS) and other capacity-constrained, older technology systems at 172 FAA and up to 199 Department of Defense terminal radar approach control facilities and associated towers.

Controllers will use STARS to provide air traffic control services to aircraft in terminal areas. Typical terminal area air traffic control services include: the separation and sequencing of air traffic, the provision of traffic alerts and weather advisories, and radar vectoring for departing and arriving traffic. The system will reduce the life-cycle cost of ownership, accommodate air traffic growth, and provide for the introduction of new automation functions that improve the safety and efficiency of the NAS.

6.1.2 The HOST Software Rewrite

In 1999 the hardware for the air traffic control system was successfully replaced. The HOST and Oceanic Computer Replacement program replaced the interim computers that had served the ATC system from the mid 1980s to the present. However, the basic en

route center automation system, which receives, processes, coordinates, distributes, and tracks information on aircraft movements throughout the nation's airspace, is based upon the original, often modified, software. Those programs were written in a computer language, JOVIAL, that is not widely used now and therefore are difficult to upgrade to accommodate new requirements.

The FAA is developing the En Route Automation Modernization (ERAM) program to replace the current NAS software and to add the capabilities required to support NAS modernization. ERAM will provide an open standards-based system that will incorporate commercial off-the-shelf and non-developmental items as much as possible. ERAM will make it easier to integrate new capabilities into the system, reduce the training needed to maintain the system, and offer enhanced simulations. The FAA is in the process of seeking industry comment on a draft ERAM package and will award a contract after appropriate review.

6.1.3 Local Area Augmentation System Development

The Local Area Augmentation System (LAAS) is an augmentation of the global positioning system (GPS) that will provide highly accurate navigation signals to suitably-equipped aircraft. LAAS will provide Category II/III precision approach and landing capability and accurate navigation signals for aircraft and vehicles on the airport surface.

The LAAS program was designed as a collaborative project between the FAA and the private sector. During the past year this approach has made significant advances towards the implementation and actual use of this advanced navigation and guidance system. Federal Express has been the leading participant in this effort and has conducted a number of successful trials at its Memphis base.

6.2 Free Flight Operational Tests

Modernizing the NAS has inherent risks because many of the new technologies have not been operationally tested. To minimize these risks and to gain a better understanding of potential challenges, the FAA has developed two risk mitigation strategies: Free Flight Phase 1 and Safe Flight 21. These programs are intended to reduce technical and financial risks through the implementation of select technologies at specific sites for evaluation by NAS users and the FAA prior to full implementation.

6.2.1 Free Flight Phase 1

The Free Flight Phase 1 (FFP1) Core Capabilities Limited Deployment initiative was designed to deliver early benefits of free flight to NAS users while mitigating the risks of implementing new technologies. Under this initiative, the FAA is evaluating five technologies: the User Request Evaluation Tool, the Traffic Manager Advisor, the Center TRACON Automation System Terminal, the Surface Movement Advisor, and Collaborative Decision Making. Each of these technologies is described briefly below.

User Request Evaluation Tool

The User Request Evaluation Tool (URET) extracts real time flight plan and tracking data from the Host computer, builds flight trajectories for all flights within or inbound to the center and identifies potential separation conflicts, up to 20 minutes in advance. URET will

permit greater route flexibility within en route airspace by enabling controllers to more effectively manage user requests.

Traffic Management Advisor

The Traffic Management Advisor (TMA) received a major aviation award for its accomplishments in increasing the efficiency of the ATC system. The TMA provides en route controllers and traffic management coordinators with automation tools to manage the flow of traffic from a single center into selected major airports, with consideration given to separation, airspace, and airport constraints.

Center TRACON Automation System Terminal

The Center TRACON Automation System (CTAS) Terminal system provides increased situational awareness in terminal airspace through the use of auxiliary displays at controller positions and large screen displays at the Traffic Management Unit. The Southern California TRACON controllers have accepted the CTAS terminal adaptation and it is being delivered to additional sites.

Surface Movement Advisor

The Surface Movement Advisor (SMA) increases awareness of traffic flows into an airport, giving ramp control operators precise touchdown times. This updated information assists airline operations in managing myriad ground resources at the terminal more efficiently, including gates, baggage handling, food services, refueling, and maintenance. Gate and ramp operators using SMA are informed of aircraft identity and position in terminal airspace, which improves their ability to reduce gate delays.

Collaborative Decision Making

Both a philosophy of traffic management and an array of computer tools that facilitate a real-time collaboration between the FAA, and the airlines, Collaborative Decision Making (CDM) provides FAA traffic flow managers and airline dispatchers with the same real-time information. It links the FAA with the dispatch systems of the airlines and provides the airlines with access to NAS data, including weather, equipment, and delays. CDM allows the FAA to manage the air traffic system more efficiently and the airlines to employ their aircraft more effectively.

6.2.2 Results of Free Flight Phase 1 Deployment

The FFP1 program has been successfully implemented at all of its initially planned sites and has been extended to others. In addition, the new technologies are bringing real and measurable improvements.

User Request Evaluation Tool prototypes are being used 22 hours a day at the Indianapolis and Memphis centers. Both facilities are providing increased direct routings to users, resulting in savings in aircraft direct operating costs of \$1.5 million per month. Also, the Indianapolis center has eliminated more than 22 altitude restrictions, saving users nearly \$1 million per year in fuel costs. URET is being deployed at five additional centers.

The Traffic Management Advisor is fully operational at three centers, providing metered traffic flows to the Dallas/Ft. Worth, Denver, and Minneapolis airports. In addition to more fuel-efficient flows, TMA has increased peak capacity at these airports by 2-to-5 percent. Additional TMA systems are deployed at centers feeding traffic to Atlanta, Los Angeles, San Francisco, and Miami airports, where the controllers use TMA to provide increased situational awareness, leading to more efficient traffic flows.

CTAS Terminal maximizes runway use by providing enhanced situational awareness at TRACONS. CTAS Terminal is operational at the Southern California TRACON, where it has increased peak capacity by three percent while reducing inefficient holding close in to the affected airports.

The Surface Movement Advisor was the first Free Flight Phase 1 program to be completed. Feedback from the airlines has been very positive; Northwest Airlines has estimated that it has been able to avoid three-to-five costly diversions weekly, especially during periods of inclement weather. Four additional airlines are currently using SMA data to improve operations.

Collaborative Decision Making allows airspace users and the FAA to share information, enabling the best use of available resources. The National Airspace System Status Information (NASSI) tool is the most recent CDM element to be completed. NASSI enables the real-time sharing of a wide variety of information about the operational status of the national airspace system. Much of this information has previously been unavailable to, or unusable by, most airspace users and service providers. NASSI includes information on includes maintenance status, runway visual ranges at over 30 airports, and the availability of Special Use Airspace.

6.2.3 Free Flight Phase 2

Free Flight Phase 2 (FFP2) builds on the successes of Free Flight Phase 1 to improve safety and efficiency within the NAS. FFP2 includes the east-to-west expansion of Phase 1 elements, including URET and TMA, to additional FAA facilities. FFP2 will provide incremental enhancements to URET and TMA during the period 2003-2005. FFP2 will deploy a number of additional capabilities, such as CDM with Collaborative Routing Coordination Tool enhancements and Controller Pilot Data Link Communication, which are described briefly below.

CDM Collaborative Routing Coordination Tool is a set of automation capabilities that can evaluate the impact of traffic flow management re-routing strategies. En route congestion management is a major focus of this tool.

Controller Pilot Data Link Communication (CPDLC) augments voice communications for limited number of air traffic messages and will provide a second communications channel for use by the pilot and controller, using data messages that are displayed in the cockpit. This will reduce delays resulting from congestion on voice channels. The initial version

of CPDLC, Build 1, will use digital data link technology to provide an operational evaluation for implementing en route data links. CPDLC Build 1A and Build 2 will expand the message set to include additional key flight data and support pilot-initiated requests.

Under FFP2, the FAA (and its collaborators) will conduct selected research activities to extend certain FFP1 capabilities and to develop others. Research activities in FFP2 include the Multi-center Traffic Management Advisor, the Surface Management System, the Direct-To-Tool, and the Problem Analysis, Resolution and Ranking (PARR) function.

6.2.4 Safe Flight 21

Safe Flight 21 is a five-year government and industry effort to demonstrate the capabilities of advanced communication, navigation, surveillance, and air traffic procedures associated with Free Flight. Safe Flight 21 expects to validate the modernization effort and accelerate its progress, while minimizing the long-term risks and costs. The Safe Flight 21 initiative will focus primarily on developing a suitable avionics technology, pilot procedures for air-to-air surveillance of other aircraft, and a compatible ground-based automatic dependent surveillance system for air traffic control facilities. The Safe Flight 21 initiatives will demonstrate the usefulness of two new technologies:

Automatic Dependent Surveillance-Broadcast and Cockpit Display of Traffic Information

A surveillance system that continuously broadcasts GPS position information, aircraft identification, altitude, velocity vector, and direction to all other aircraft and air traffic control facilities within a specific area. Automatic Dependent Surveillance-Broadcast (ADS-B) information will be displayed in the cockpit via a cockpit display of traffic information (CDTI) unit, providing the pilot with greater situational awareness. ADS-B transmissions will also provide controllers with a more complete picture of traffic and will update that information more frequently than will other surveillance equipment. On the surface, ground vehicles can also use ADS-B and CDTI to be visible to, and to see, taxiing aircraft.

Traffic Information System-Broadcast/Flight Information Service

The Traffic Information System Broadcast (TIS-B) and the Flight Information Service (FIS) are communications systems that will transmit traffic, weather, and other information available on the ground to the cockpit. TIS-B/FIS will also provide pilots with greater situational awareness.

The Safe Flight 21 program will also quantify operational benefits, demonstrate capabilities, and collect data on the performance of three candidate data link technologies for air-to-air surveillance: Mode Select (Mode S) Extended Squitter, Universal Access Transceiver, and VHF Data Link (VDL) Mode 4. Safe Flight 21 demonstration projects have been initiated at two sites: in the Ohio River Valley in collaboration with the Cargo Airline Association and in western Alaska with commercial aircraft providing passenger, mail, and freight services. A common design is being used for the two project sites to facilitate the collection and analysis of data.

6.2.4.1 Ohio River Valley Project

Safe Flight 21's Ohio River Valley Project is testing ADS-B avionics on commercial cargo aircraft in the Ohio River Valley. These tests are taking place in terminal areas with significant cargo operations, including Memphis, Tennessee; Wilmington, Ohio; Louisville, Kentucky; Scott Air Force Base, Illinois, and Nashville, Tennessee. The Ohio River Valley Project is co-sponsored by the Cargo Airline Association (CAA) and the FAA. The CAA has purchased, equipped, and is maintaining the avionics for the test aircraft. The CAA members are conducting revenue flights with these aircraft to evaluate the systems' performance in normal operations.

The FAA has purchased, installed, and is maintaining ground systems at the five sites. A ground broadcast server has been installed at the Wilmington site that receives data from the other sites and depicts ADS-B targets fused with radar targets. As the project proceeds, fused ADS-B and radar target data will be made available to suitably-equipped aircraft to enable the pilots to see both targets on a cockpit display, along with selected broadcast information such as weather maps, special use airspace status, and wind shear alerts.

The Ohio River Valley Project is being assessed in a series of Operational Evaluations. The first evaluation demonstration took place in July 1999 at the Wilmington site. It concentrated on measuring the improvement in the test aircraft's ability to make approaches in low visibility conditions and their enhanced ability to see and avoid adjacent traffic. Cargo carriers, the FAA, NASA, the military, and academia participated in this initial evaluation. During the demonstration, aircraft equipped with ADS-B enabled pilots to consistently maintain close separation.

The second operational evaluation took place in October 2000 at the Louisville site, with some 20 aircraft. CAA members provided eight aircraft and other participants, such as NASA, the U.S. Navy, and the Aircraft Owners and Pilots Association provided additional aircraft for the trials. The third operational evaluation took place at the Memphis site in May 2001. It followed up on the successes of the previous trials and demonstrated additional capabilities of the avionics technology.

6.2.4.2 Alaska Capstone Program

The Capstone Program was developed by the FAA in response to an National Transportation Safety Board (NTSB) safety study, Aviation Safety in Alaska, to address Alaska's high accident rate for small aircraft, which is five times the national average. A recent FAA-sponsored study estimated that 38 percent of commercial operator accidents in Alaska could be avoided if information on position relative to terrain and real-time weather information were available to pilots in the cockpit. The principal objective of the Capstone Program is to improve pilots' situational awareness of the flight environment and to thereby avoid mid-air collisions and controlled flight into terrain. Although the FAA plans to initially demonstrate the benefits of these technologies in Alaska, it will eventually extend those technologies to the entire NAS.

The FAA has equipped 120 commercial aircraft in a non-radar environment in the Yukon-Kuskokwim Delta region of southwest Alaska with the Capstone avionics suite. It includes a cockpit multifunction display, a GPS navigation/communications unit, a Universal Access Transceiver data link unit, and a GPS-based terrain database of Alaska.

The suite enables each participating aircraft to broadcast its identification, position, and altitude, climb rate, and direction and to receive similar signals from other aircraft.

The FAA has begun the installation of a network of data-link ground stations that will transmit radar targets of non-participating aircraft to the Capstone aircraft. In addition, the ground stations will transmit flight information services, including weather reports and forecasts, maps, status of special use airspace, pilot reports, and notices to airmen. The FAA is also publishing non-precision approaches and installing automated weather observation systems at ten village airports in the Delta region.

The University of Alaska-Anchorage (UAA) conducted training sessions for Capstone and has completed an in-depth safety study of Capstone. UAA has begun training a cadre of instructors who will in turn conduct individual company training. The training program began in Bethel, Alaska in early February 2000 and will continue until each participating commercial company has at least one fully trained instructor and a complete set of Capstone modules with reference library materials. The safety study is assessing the benefits of the Capstone avionics and the use of new flight procedures.

The initial improvements of Capstone are directed towards pilots conducting Visual Flight Rule (VFR) operations. In the future, the FAA plans to certify systems and equipment and develop enhanced operational procedures for Instrument Flight Rule (IFR) operations. When this is accomplished, ADS-B can be used for air traffic control functions just as radar is now used.